

APPLICATION
FOR
UNITED STATES LETTERS PATENT

TITLE: Packaging System for Die-Up Connection of a Die-Down
Oriented Integrated Circuit

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27723

PATENT TRADEMARK OFFICE

CERTIFICATE OF MAILING

"EXPRESS MAIL Mailing Label Number: EL487846101US Date of Deposit: March 30, 2001

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PACKAGING SYSTEM FOR DIE-UP CONNECTION OF A DIE-DOWN ORIENTED INTEGRATED CIRCUIT

Background Of The Invention

5 1. Field of the Invention.

The present invention relates to integrated circuit packaging. More particularly, the present invention relates to the arrangement for attaching a die-down-oriented integrated circuit in a die-up-oriented package such a chip scale package land grid array or a lead frame.

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2. Description of the Prior Art.

Integrated circuits are connected to other integrated circuits or other electrical devices via printed circuit boards having metal connectors. The integrated circuits are formed on sections of semiconductor wafers or die using well-known fabrication techniques. An integrated circuit of a die is attached to a substrate designed to provide structural support, thermal protection, and a means to fan out metal connectors or traces from the circuit to the printed circuit board. The combination of the integrated circuit and its substrate/metal connectors is referred to as the integrated circuit package. The package is essentially a housing that is used either to plug the device into sockets of the circuit board or to solder the device onto surface contacts of the board.

The most common type of semiconductor packaging to have been used is the small-scale outline package such as shown in FIG. 1. That package includes a semiconductor chip **10** supported on and attached to a die attach pad (DAP) **11** encapsulated in an encapsulating material **12**. The chip **10** includes bond pads represented by pads **13** and **14** connected to bond wires **15** and **16** that are connected to respective lead frames **17** and **18** of a lead frame. The lead frame connects the chip **10** to traces of the printed circuit board. The bond pads of the chip **10** are located on the top surface of the chip **10**. The desired connection of the chip **10** to the printed circuit board has pads **13** and **14** connected to the lead frames **17** and **18** on the same side of the package.

FIG. 2 illustrates an alternative package design. That package includes mounting of the die or chip **20** on a DAP **21**. Contacts **22** and **23** of the chip **20** are coupled to a bottom side of the lead frame by way of wire bonds **24** and **25** to lead frame leads **26** and **27**. The construction process for producing the package of FIG. 2 is substantially the same as the process used to produce the package of FIG. 1. The package of FIG. 2 is commonly referred to as a die-down package while that of FIG. 1 is a die-up package.

The packaging types described must be designed with common connector protocols in mind. That is, there are conventions for the ways in which electronic devices are interconnected, requiring the chip manufacturers to fabricate chips and, more specifically, their contacts, with a particular orientation. The contact pads of the packages shown in FIGS. 1-3 must be positioned to match the mounting configuration established on the printed circuit board. For example, a chip to be coupled to a high-potential power rail, a low potential power rail, two inputs and two outputs must be configured so that the chip's contacts are matched to the traces associated with each of those elements. For a die-down package such as the package shown in FIG. 2, the chip is fabricated so that its contacts are on what becomes the bottom of the structure. On the other hand, a chip packaged in a standard lead frame package such as that shown in FIG. 1, is fabricated so that its contacts are on what is the top of the structure. Thus, there are two types of chip orientations that must be fabricated as a function of the particular packaging type employed. Those chips that are "die down" and those that are "die up." While it is common practice to fabricate both types of die orientations, it would be more cost effective to be able to fabricate just one type that could be used in either type of package configuration.

Therefore, what is needed is a packaging arrangement that would permit the connection of a die-down chip in a die-up configuration.

Summary Of The Invention

It is an object of the present invention to provide a packaging arrangement that would permit the connection of a die-down chip in a die-up configuration.

This and other objects are achieved in the present invention by providing a connection substrate with traces or connection lines that run under the die. The die is a die fabricated as a die down one that is positioned on the substrate with the contacts on the side opposite that of the substrate so that it is in a die up position. Ordinarily, a die down die having its contacts located on the exposed side of the die would not be connectable in a die up package because the

contacts of the die would be adjacent to the wrong traces or pins of the substrate.

However, the substrate of the present invention includes those traces or pins as passing from one side of the die to the other so that correct connections may be established. Specifically, the connectors are routed under the die, allowing a die-down design to be wire bonded in a die-up package while maintaining the same external configuration associated with a die-up package. The substrate may be a ceramic or organic substrate or a standard lead frame. An electrically non-conductive attach material is used to connect the die to the substrate.

The packaging arrangement of the present invention allows a die manufacturer to fabricate die-down oriented die that may be used in a die-up package as well as a die-down package. Further, since the die may be coupled to a circuit board using connectors and traces, it is suitable for coupling a die-down die in a package that may otherwise be too small for flip chip packaging.

These and other advantages of the present invention will become apparent upon review of the following detailed description, the accompanying drawings, and the appended claims.

Brief Description of the Drawings

FIG. 1 is a cross-sectional side view of a lead frame-based die-up package of the prior art.

FIG. 2 is a cross-sectional side view of a lead frame-based die-down package of the prior art.

FIG. 3 is a perspective view of the die-down/die-up orientation package of the present invention with a die in place on a ceramic substrate.

FIG. 4 is a top view of the substrate of the package of the present invention showing the trace routings that run under the die when in place.

5 FIG. 5 is a top view of the package of the present invention without the die in place on the substrate.

FIG. 6 is a perspective view of a second embodiment of the die-down/die-up orientation package of the present invention with a die in place on a lead frame.

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Description Of The Preferred Embodiments Of The Invention

A die package **100** of the present invention is shown in FIGS. 3 and 4. The package **100** includes a substrate **101** with a plurality of patterned traces **102-107** that provide connections from a die **108** to a printed circuit board (not shown). Although six traces have been shown, it is to be understood that more or fewer may be applied to the substrate **101** as a function of the particular contact requirements associated with the active components of the die **108**. For the packaging arrangement shown in the drawings, the die **108** is of a die-down type such that its conductive contacts **109-114** would ordinarily be positioned to provide proper pinout when the die **108** is attached to the bottom of the substrate **101**. That is, the die package **100** of the present invention enables orientation of the die **108** in a die up arrangement although the die **108** is fabricated with a die down orientation. The contacts **109-114** are connected to the traces **102-107** by way of connector wires **115-120**. The arrangement of the wires **115-120** and the traces **102-107** effectively "flip-flop" the orientation of the contacts **109-114** so that proper coupling to vias **121-126** connected to the underlying printed circuit board is established.

The substrate **101** may be fabricated as a ceramic substrate or an organic substrate. It includes a first side **101a** and a second side **101b**. The die **108** is physically connected to the substrate **101** using a non-electrically-conductive material such as a thermally conductive epoxy, for example. The die **108**

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includes a first side **108a** and a second side **108b**, such that the first side **108a** is opposite the first side **101a** of the substrate **101**. The same opposing relation can be said for the second side **108b** of the die **108** and the second side **101b** of the substrate **101**. It is important that the die **108** not contact the substrate **101**

5 directly in order to avoid shorting. In that regard, it is desirable to ensure that the adhering material spaces the die **108** from the substrate **101** while maintaining adequate physical support. The package **100** further includes an encapsulant **127** to seal the die **108** and connectors in to protect the substrate **101** and wire bonding stability. The traces **102-107** may be applied to the substrate **101** after
10 substrate formation or as part of the substrate fabrication process.

As illustrated in FIG. 5, the traces **102-107** on the substrate **101** are arranged to pass under the die **108** when the die **108** is attached to the substrate **101**. The traces **102-107** are routed in an organized manner so that contacts of the die **108** on the first side **108a** are electrically connected to traces having vias on the second side **101b** of the substrate **101** and the contacts on the second
15 side **108b** are electrically connected to traces having vias on the first side **101a** of the substrate **101**. As indicated, the traces **102-107** and the vias **121-126** may be established on the substrate **101** in any well known manner. A goal of the present invention shown in the drawings is to electrically connect contacts on one
20 side of the die **108** to vias on the opposite side of the substrate **101**. More generally, the present invention is directed to arranging traces and wire contacts so that a die-down die may be packaged in a die-up orientation.

Although the present invention has been described as a package system **100** designed to couple the die **108** to a substrate **101** including traces **102-107**, it
25 may alternatively be configured as an arrangement to couple the die **108** to a lead frame **128**, as shown in FIG. 6. The package **200** of FIG. 6 includes a plurality of leads **129-134** that provide connections from the die **108** to a printed circuit board (not shown). Although six leads have been shown, it is to be understood that more or fewer may be applied as a function of the particular contact requirements
30 associated with the active components of the die **108**. For the packaging arrangement shown, the die **108** is of a die-down type such that its conductive

contacts **109-114** would ordinarily be positioned for mounting the die **108** to the bottom side of the leads **129-134**. That is, the die package **200** of the present invention enables orientation of the die **108** in a die up arrangement although the die **108** is fabricated with a die down orientation. The contacts **109-114** are
5 connected to the leads **129-134** by way of connector wires **115-120**. The arrangement of the wires **115-120** and the leads **129-134** effectively "flip-flop" the orientation of the contacts **109-114** so that proper coupling to paddle contacts **135-140** connected to the underlying printed circuit board is established. The leads **129-134** may then be connected to a printed circuit board in a well-known
10 manner.

As illustrated in FIG. 6, the leads **129-134** of the lead frame **128** are arranged to pass under the die **108** when the die **108** is attached to the lead frame **128**. The leads **129-134** are routed in an organized manner so that contacts of the die **108** on its first side **108a** are electrically connected to paddles
15 having circuit board contacts on a second side **128b** of the lead frame **128** and the contacts on the second side **108b** of the die **108** are electrically connected to paddles having board contacts on a first side **128a** of the lead frame **128**. The leads **129-134** may be fabricated in any well-known manner. The die **108** is connected to the lead frame **128** using a thermally conductive and electrically
20 non-conductive material. The package **200** of FIG. 6 arranges the lead frame leads **129-134** so that a die-down die may be packaged in a die-up orientation.

While the invention has been described with reference to particular example embodiments, it is intended to cover all modifications and equivalents within the scope of the following claims.